THURSDAY, SEPTEMBER 13, 1894.

BACTERIA IN WATER.

Micro-Organisms in Water; their Significance, Identification, and Removal. By Prof. Percy Frankland and Mrs. Percy Frankland. (London: Longmans, Green, and Co., 1894.)

ON perusing this volume, there can be left no doubt in the mind of anyone who has paid attention to the enormous progress in the knowledge of micro-organisms in water, that the authors have succeeded in producing a work which testifies to a full and accurate survey of the subject, and to a large amount of original observations carried out by the modern approved methods. For these reasons we venture to say that this volume will occupy the position of a valuable text-book and standard work on the subject of micro-organisms in water. The views which the authors, in common with modern sanitarians, hold as to the relative value of the chemical and biological examination of potable waters, deserves special attention on behalf of some distinguished chemists, on whose mind the whole progress of bacteriological science seems to have as yet made but little impression; in this connection we quote, from p. 117, chapter v., the authors' statement which, being those of a distinguished chemist, it is to be hoped will have the desired effect:—"If water which is known to have received sewage matters (and the *entire* exclusion of such from supplies drawn from rivers is practically impossible) is to be supplied for dietetic use, and if this water, as is so often the case, is not objectionable on account of the absolute quantity of organic matter, as revealed by chemical analysis, which it contains, but only of the suspicious origin of a part of this organic matter, then it is evident that in the purification of such water the point to be taken primarily into consideration is how the organic life it contains can be reduced to a minimum." The authors might have further added that the chemical analysis only of such waters is for sanitary purposes of little practical use, since a water may contain less than the recognised amount of organic matter, and yet be dangerous for drinking purposes on account of the presence in it of some undesired pathogenic microbes. The amount of organic matter and the presence of these latter in water need not, and in some cases (*e.g.* the well-known outbreak of typhoid fever at Caterham) do not bear a constant or a definite relation to one another. As a more recent illustration of this kind, the well-known instance of the cholera in Hamburg and Altona in 1892 may be quoted.

As is well known, Hamburg and Altona (p. 152) "are dependent upon the river Elbe for their water supply, but whereas in the case of Hamburg the intake is situated *above* the city, the supply for Altona is abstracted below Hamburg after it has received the sewage of a population of close upon 800,000 persons. The Hamburg water was therefore, to start with, relatively pure when compared with that destined for the use of Altona. But what was the fate of these two towns as regards cholera? Situated side by side, absolutely contiguous in fact, with nothing in their surroundings or in the nature of their population to especially distinguish them, in the one (Hamburg) cholera swept away thousands, whilst in the other (Altona) the scourge was scarcely felt." . . . "The Hamburg water, to start with, was relatively pure when compared with the foul liquid abstracted from the Elbe by Altona; but whereas in the one case the water was submitted to careful filtration through sand before delivery, in Hamburg the Elbe was distributed in its raw condition as taken from the river." Here we have water coming originally from the same source, which was yet widely different in biological respects for the two sets of consumers:—

(*a*) Hamburg water, chemically comparatively pure.

(*b*) Altona water, chemically foul, owing to great sewage pollution; yet the Hamburg water proved deadly because rich in cholera germs, while the Altona water, from which most of these germs had been removed by careful filtration, but chemically still impure, did little harm.

Prof. Percy Frankland, when before the Royal Commission on Metropolitan Water Supply, seemed to have resented a statement made by myself before that Commission as to the comparatively small value that sanitarians attribute to a purely chemical analysis of water; inasmuch as he (Prof. Frankland) quoted the very water of Hamburg as proving the importance of chemical analysis. He said that the Hamburg water which he had examined for the editor of the *British Medical Journal*, would already, on chemical grounds, have been condemned as unwholesome water. But he was immediately after this answer confronted with the information not then known to him (Prof. Frankland), given to him by one of the Commissioners, viz. that the population of Altona drank with comparative immunity the same water, only chemically more polluted, the difference between the two waters being that the Hamburg water was consumed unfiltered, while the Altona water was filtered before delivery. From what we have quoted above, it is satisfactory to find that Prof. P. Frankland, in common with others, does not attribute great value to chemical analysis alone.

The subject of preparation of culture media for bacterioscopic water-analysis, and of the methods of isolation of micro-organisms from water, are treated in a fairly exhaustive manner in chapter i. We miss, however, the description of the methods of making agar plates, probably because the authors as a rule used only gelatine plates. Chapter ii. gives a detailed description of the methods of staining bacteria. It is not quite clear where, in the examination of micro-organisms in water, the staining of sections of tubercle, leprous, and other pathological tissues comes in; at any rate, if quoted, it might as well have been quoted more perfectly. Chapter iii. deals with the examination of water for micro-organisms; chapter iv. with the bacterial contents of various waters, of rivers, lakes, wells, springs, sea-water, ice, hail, rain, &c.; chapter v. with the purification of water for drinking purposes by the various filters in use on large and small scales, sterilisation by heat, subsidence, chemical treatment, &c.; and chapter vi. on the multiplication of the micro-organisms in water. All these subjects are treated in great detail, both on account of the large amount of bibliography, as also on accoun of a considerable amount of work contributed by the authors themselves. There are, however, two subjects on which it is necessary to make some comment. The first refers to a passage on p. 119; they say: "In the year 1885 Koch's gelatine process of water examination was first introduced into this country by one of us."

I am quite sure that Prof. P. Frankland hereby quite unintentionally omitted to state the fact that Dr. Angus Smith (*The Sanitary Record*, 1883) was the first to apply the gelatine test for showing the relative number and the different characters of the colonies of the microbes present in water.

The second point refers to the factors which determine the efficient character of sand filters. From p. 119 to p. 142 we have a detailed account, with numerous tables, of the results of the bacteriological examination of London waters "by one of us," yet no mention is made and no indication is given of one of the most important factors (*cæteris paribus*) in efficient sand filtration, viz. the formation in the superficial layers of the filter bed of a slime (Schlamm); it is precisely after the formation of this "slime" that the filter becomes efficient, it is inefficient before the "slime" is formed. The authors have had abundant indications as to the importance of this "slime"; they quote on p. 158 researches by Piefke, who demonstrated already in 1887 that (p. 159) "it is the slime deposit on the sand which constitutes the real filtering material in the water-works' filter." Further indication of the importance of this "slime" was given to the authors by Prof. Lankester's extremely valuable evidence before the Royal Commission on Metropolitan Water Supply, November 1892, and lastly by Koch's paper on water filtration in the *Zeitschr. f. Hygiene und Infektions*, vol. xiv. Koch clearly shows that the sooner this slime is formed—water which initially contains a greater amount of impurity would form it sooner than water initially pure—the sooner the filtration becomes efficient; further, that on renewal (by scraping) of the surface of the filter this protective slime is removed, and therefore the filter for the time becomes inefficient; then the influence of frost on this slimy layer, and a variety of other important points connected with this slime. All these and others are of the utmost importance as regards the real understanding of the working of sand filters; *e.g.* the exact nature of the slime, the conditions affecting its formation, the differences of its formation in the filter-beds of the various London Water Companies, and at various periods, &c. All these points require elucidation, and one must regret that the authors have missed a valuable opportunity to treat of these in the book; since the researches "by one of us" made of the London waters in 1886, which are quoted in full in the work, no real progress appears to have been made. One thing, however, is brought out by the observations not only of Fraenkel and of Piefke, but of all that have worked on the question of purification of drinking-water by filtration, and that is (p. 157) that "even under the most favourable conditions of working the sand filters do not form a complete obstacle to the passage of micro-organisms."

Chapter vii., on the detection of pathogenic bacteria in water, gives an extensive bibliography and the most reliable methods for the detection of bacteria, the typhoid bacilli, and Koch's comma bacillus receiving a not undeservedly large share of attention. With regard to the differentiation of bacillus coli and typhoid bacillus by the presence or absence of gas-bubbles in gelatine cultures, the authors state (p. 269): "This distinction has been shown by one of us to be available in an extremely simple form for the differentiation of the two organisms," viz. the bacillus coli forming gas-bubbles in gelatine shake cultures already after twenty-four hours' incubation at ordinary temperature, while the bacillus of typhoid does not do so. I am able to confirm this, and to state that this characteristic formation of gas-bubbles by bacillus coli in gelatine shake cultures has been known and practised in my laboratory for more than two years, and is described by me in the Reports of the Medical Officer for the Local Government Board, 1892–1893; also in the *Journal of Pathology and Bacteriology* November 1893; and in the *Centralblatt für Backt. und Parasit.* vol. xv. Nos. 8 and 9.

There is one further subject to be mentioned, viz. on p. 272 and p. 273. The authors in using Parietti's method, in order to detect the typhoid bacillus in water, recommend adding to the cultivating medium "1 to 10 drops of the water under investigation"; if, as is almost invariably the case, the typhoid bacillus is present in the water in a highly diluted state, *i.e.* few examples in a large bulk of water, how the authors can under these conditions hope to recover the typhoid bacillus by using 1 to 10 drops of the water, is difficult to see. True, later on, on p. 285, an important addition *in small print* is made in the shape of a note at the end of chapter vii., to the effect that in "examining water for the typhoid bacillus it is advisable to pass a considerable volume, 250 c.c. or upwards" (this sounds rather different from 1 to 10 drops) "through a sterile porcelain or infusorial earth filter, and then to transfer this deposit on the surface of the cylinder by means of a sterile brush into a small quantity of sterile water"; this is then used for cultivation. This is the identical method which was used by me with success in the summer of 1893 in detecting the typhoid bacillus in the Worthing water, and soon after in the water from a polluted well in Rotherham.[1]

For the means by which Koch's cholera vibrio can be differentiated from other vibrios that have been hitherto found in water, the authors (on p. 279) mention Koch's conclusion that the absence of indol reaction, as well as the absence of any pathogenic effects on guinea-pigs, sufficiently distinguish the non-cholera vibrio from Koch's comma bacillus. This conclusion is definitely contradicted by a number of more recent observations made by independent workers, amongst them notably R. Pfeiffer (*Archiv. f. Hyg. und Infekt.* vol. xvii.).

Chapter viii. treats of the vitality of particular pathogenic bacteria in different waters; a large amount of bibliography with tabulated results by the various authors are given *in extenso*. Turning to the vitality of the typhoid bacillus, we find one observer (p. 290), Braem, gives the vitality of this bacillus in distilled water 188 days; Hochstetter, on the other hand, not exceeding five days; Meade Boulton, from two to three and ten to fourteen days; Wolffhügel and Riedel, thirty-two days. Similarly as regards the vitality of Koch's cholera vibrio in distilled water, Percy Frankland states that none were discoverable on the second day (the vibrio was initially in a weakened condition); Hochstetter, twenty-four hours to seven days; Nicati and Rietch, more than twenty days; Slater, five hours; Strauss and Dubarry, fourteen days. These differences are extremely perplexing and materially interfere with the value of the statements. As all these observers used distilled water, the differences as to the vitality must be due to the microbes themselves; the readiest explanation is this, that the different observers used the microbes in different states of resistance. It is perfectly well known that a variety of conditions, such as the nature of the nutritive medium in which the organisms had been growing, the age and the pedigree of the culture used, determine the resistance and vitality; unless, therefore, in all cases the best and most favourable cultures are used, the observations are of small value, and the authors justly (see pp. 331 and 334) lay stress on similar points.

---

[1] A similar remark may be made to a passage on p. 283. The authors in describing the detection of anthrax spores in water, state:—"A method has been devised by one of us (1893) suitable for the detection of anthrax spores when present along with other micro-organisms in water." This consists in killing by heat the non-spore-bearing forms, while the spores, being more resisting, survive. This method "one of us" might have found described in Klein's "Micro-organism and Disease," 3rd edition, 1886, p. 106.

One conclusion proceeds with clearness from the recorded observations, viz. that (p. 261) "a number of bacteria, possessing pathogenic properties of the most pronounced character, have been detected in natural waters from time to time," and it is therefore not quite correct to assume, as is generally done, that typhoid and cholera are the only diseases whose germs are distributed by water, nor is it justifiable to limit our attention to these two species only, because the whole subject of the identification of specific bacteria in water is practically still in its initial phase.

Chapter ix. and last, on the action of light on micro-organisms, is extremely well written and gives a detailed account of this important and ever-widening field of research; the history of the whole subject and the very valuable results obtained by the authors (or rather "by one of us"[1]) are described in a thorough and readable manner. It is to be regretted that the beautiful and well-known researches of Prof. Marshall Ward on the fundamental difference of action of the red and blue part of the spectrum should have been passed over.

In an appendix a valuable and up-to-date systematic description is given of the micro-organisms that have been hitherto found in water, by which their identification is greatly facilitated. We only wish the authors had not ventured to classify them into pathogenic and non-pathogenic bacteria, the former indicated by being printed in red letters, the latter in black. The authors do not accurately define, for obvious reasons, what is and what is not a pathogenic micro-organism, but give a list of "those microbes which have been found to be pathogenic to man or animals." The classification in the appendix is both incorrect and misleading. It is incorrect because a great many of the microbes mentioned here as non-pathogenic, produce disease and death in the guinea-pig if injected in sufficiently large doses into the peritoneal cavity; it is misleading because microbes are mentioned here as pathogenic, *e.g.* the *Bacillus coli*, the *Proteus vulgaris*, the *Proteus mirabilis*, which have no greater claim to such a designation than the *Bacillus prodigiosus* or the *Bacillus subtilis*; for it has been conclusively established, by a number of independent observers, that these latter act in the same way pathogenetically when injected into the guinea-pig's peritoneum as the *Bacillus coli*, the vibrio of Koch, or the bacillus of typhoid fever.

In conclusion, we have no hesitation in saying that, short of the omissions that we have pointed out, the book will take a prominent place amongst the standard works on micro-organisms in water. E. KLEIN.

---

[1] This expression occurs over thirty times.

RITTER'S "ASIA," RUSSIAN ADDENDA.

East Siberia. Part i., *being the Sayan Highlands in the Government of Irkutsk, in the South of the great Siberian Highway, up to the South-western Extremity of Lake Baikal.* By P. P. Semenoff, I. D. Chersky, and G. G. von Petz. (St. Petersburg, 1894.)

THIS volume belongs to the great undertaking of the Russian Geographical Society, which was begun many years ago with the intention of publishing addenda to those parts of Ritter's "Asia" which deal with regions of the great continent belonging to Russia, or touching its frontiers. The large number of geographical researches which have been made since the year 1832, when Ritter's great work had been published, and the difficulty of treating them with the same details as Ritter had treated the scanty information available sixty years ago, have resulted in many delays in the appearance of the promised volumes, and even this last one comes out as the work of three different persons—P. P. Semenoff taking it up when Chersky had met with an untimely death in the far north of Siberia. But in the hands of P. P. Semenoff, the volume we now have before us bears no traces of an incomplete posthumous publication. On the contrary, it is a well-finished work, worthy to take one of the first places among the several excellent volumes of "Russian Addenda" previously published.

Not only the great lines of Ritter's classical work and its spirit could be fully maintained, but the many explorations which have been made in this region during the last sixty years, have only confirmed the correctness of the conceptions of the great geographer. The Sayan mountains appear, indeed, as a huge border-wall of the great massive upheaval of North-west Mongolia, and as a part of the immense border-ridges which fringe the high plateau of East Central Asia. And in the Alpine regions beyond it there is no trace of the chains which Humboldt wanted to run along the parallels, and the meridians. There is, in the Tunka, the Kitoi, and the Byelaya Alps, simply a succession of chains running roughly parallel to the border-ridge.

In the huge border-ridge lies the 11,500 feet high Munku Sardyk, the highest mountain of East Siberia, which till lately was supposed to be the only one snow-clad peak in that part of Asia. Its glaciers and its summit had already been visited and described by Radde in 1856, but the present volume contains also the most interesting observations of Captain Bobyr, who has re-visited the peak, and from whom we learn that four more peaks rise above the snow-line in the same part of the